Witekio

EMBEDDING SUCCESS

System upgrade with SWUpdate

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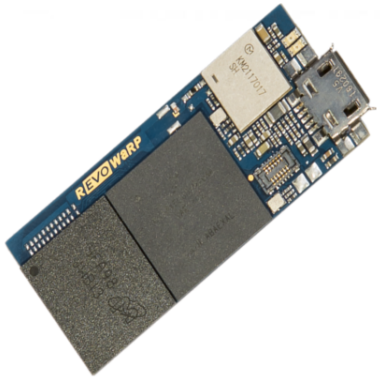
Gabriel Huau

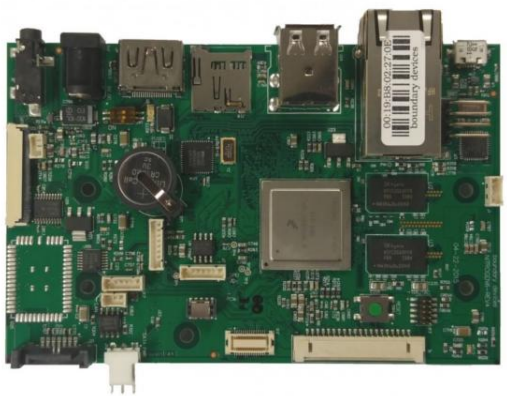
Embedded Software Engineer

TABLE OF CONTENTS

ABOUT THE PRESENTER

- Open-Source Enthusiast
  - Buildroot / Linux kernel / U-Boot / ...
- Working @ Witekio
- Android, Linux and QNX:
  - BSP adaptation
  - Driver development
  - System integration





Introduction

WHY ARE WE HERE?

- Importance of product updates in the field
  - Bug / Security fixes
  - New features
- What's different in embedded systems?
  - Power-safe
  - Access to target

WHY ARE WE HERE?

- Focusing on SWUpdate
  - Update **framework**
  - Open-Source (of course)
  - Created & maintained by Stefano Babic from Denx
- Cover all aspects
  - From update creation to download to flashing
- Past experiences
  - Customers / Users feedback
- Practical approach
  - Demonstration on actual HW

Architecture

WHAT TO UPDATE?

- Bootloader
  - Not covered in this talk
  - Depends on HW capabilities
- Kernel
- Device tree
- Root file system
- Application data

ATOMIC UPDATE VS PACKAGE MANAGER

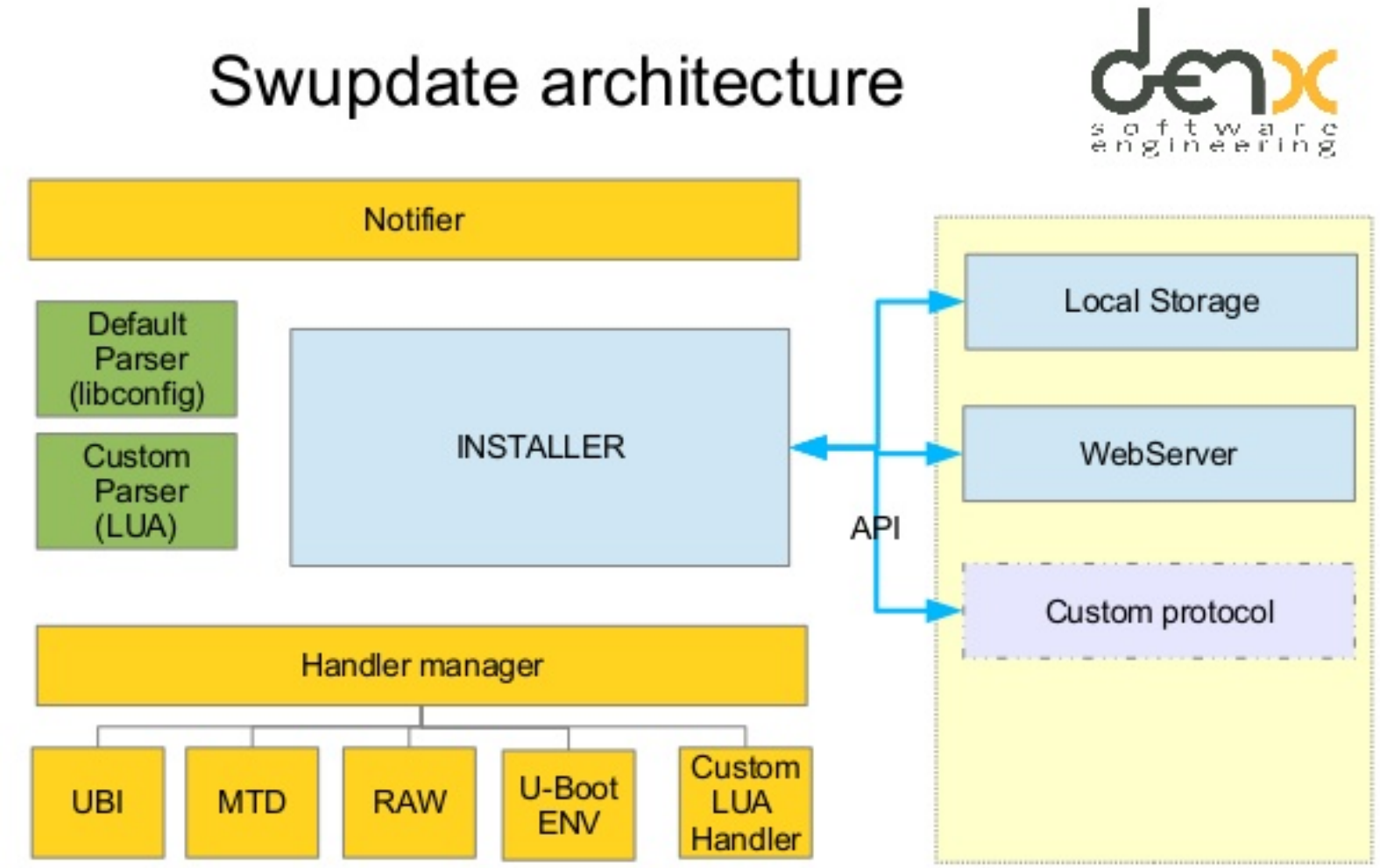
Package manager pros:

- small update image

Package manager cons:

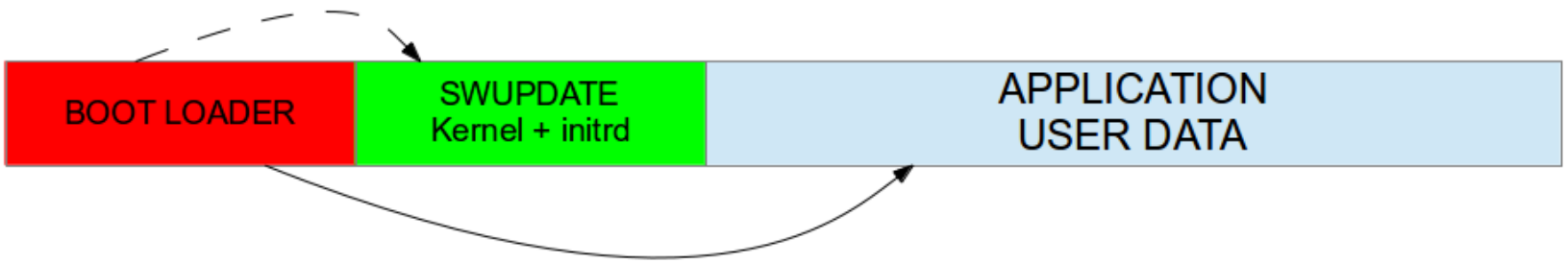
- upgrade not atomic (in general ...)
- hard for testing and support
- more places where things can go wrong

SWUPDATE OVERVIEW



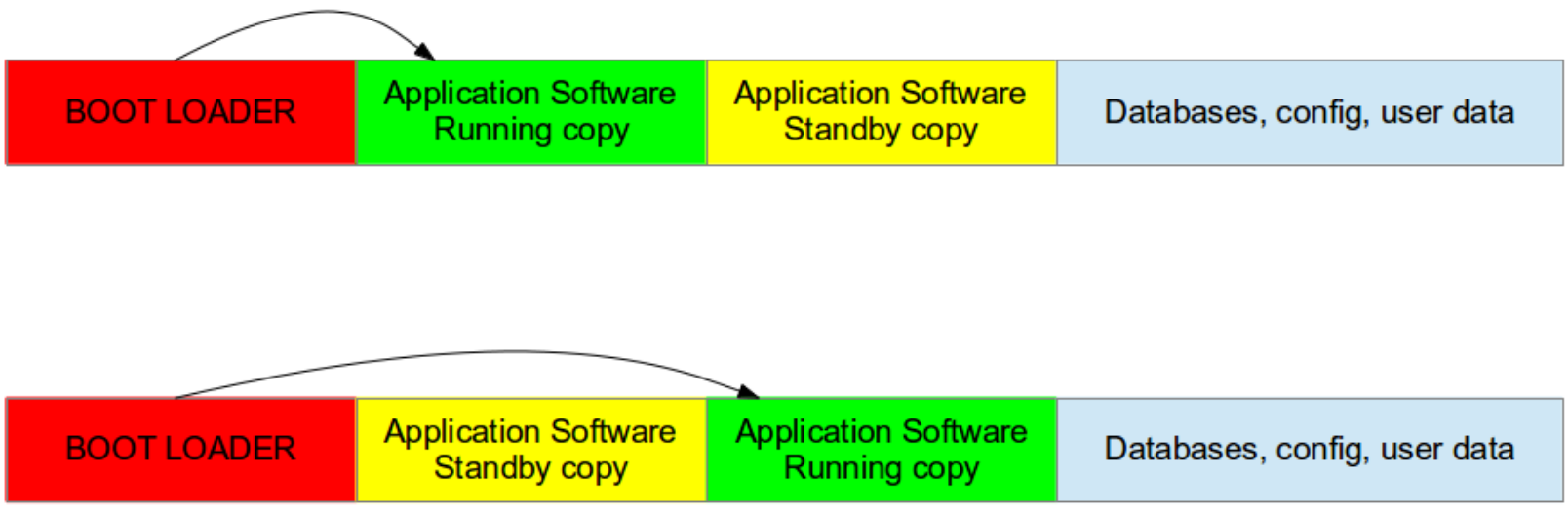
PARTITIONS LAYOUT

- **Single copy** - running as standalone image
  - Consists of kernel / dt + initrd
  - Much smaller than entire system
  - Bootloader in charge of loading standalone image
  - System must reboot to enter update process



PARTITIONS LAYOUT

- **Double copy** with fall-back
  - Requires twice as much space
  - Guarantees there's always a working copy!
  - Bootloader in charge of booting proper image



SWUPDATE TOOL

- Runs / applies update from **Linux user-space**
  - More generic than bootloader
  - More drivers / protocols supported
  - Lots of tools / libraries available
- **Full update** only
  - Atomic process
  - Single image delivery
- Small footprint: compressed ramdisk of 4MB (could be used for rescue image)

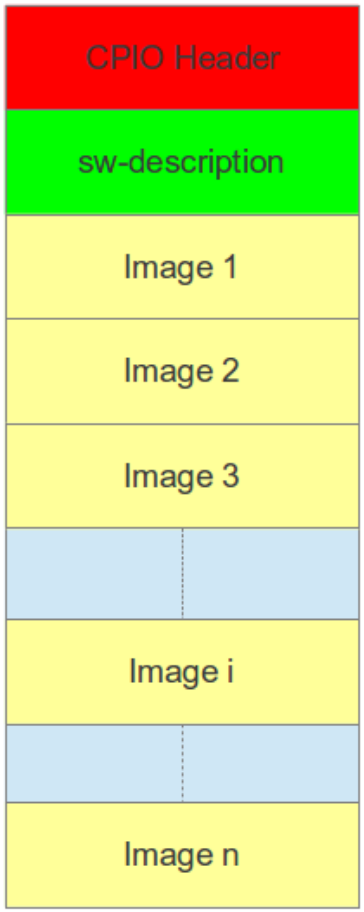
AVAILABLE FEATURES

- Update interfaces
  - Local
    - USB, SD, UART, etc...
  - OTA / Remote
    - HTTP / web based / HawkBit
- **Security** (hash, signature, etc...)
- Standard parser with many handlers
  - Images to be installed; can be compressed
  - Scripts; shell or LUA, called pre/post install
  - U-Boot; to update env variables
  - **Custom handlers**
- Streaming support: no temporary copy on the target

UPDATE IMAGE FORMAT

- CPIO format for his simplicity
- sw-description: to descript the update
- images data / update resources

- `.swu` file



EXAMPLE OF .SWU FILE

```
software =
{
        version = "1.0.1";

        nitrogen6x = {
                hardware- compatibility : [ "REV4" ];

                images: (
                        {
                                filename = "rootfs.ext2.gz";
                                device = "/dev/update";
                                type = "raw";
                                sha256 = "1
e0f63c1e6026acd7bba16ced9693aa862f7df04e423b668acaf9eb3fa4330a2";
                                compressed = true;
                        }
                );

                scripts : (
                        {
                                filename = "update.sh";
                                type = " shellscript ";
                                sha256 = "
faaaa3096b01c196d20903e21ec88757834e68f09de4c2edd721ad8b83a9628e";
                        }
                );
        };
}
```

Main block

Board specific

Handler for images

Handler for scripts

LOCAL UPDATE: USB EXAMPLE

- Once the drive is mounted and the update located, you can start swupdate with the -i option:

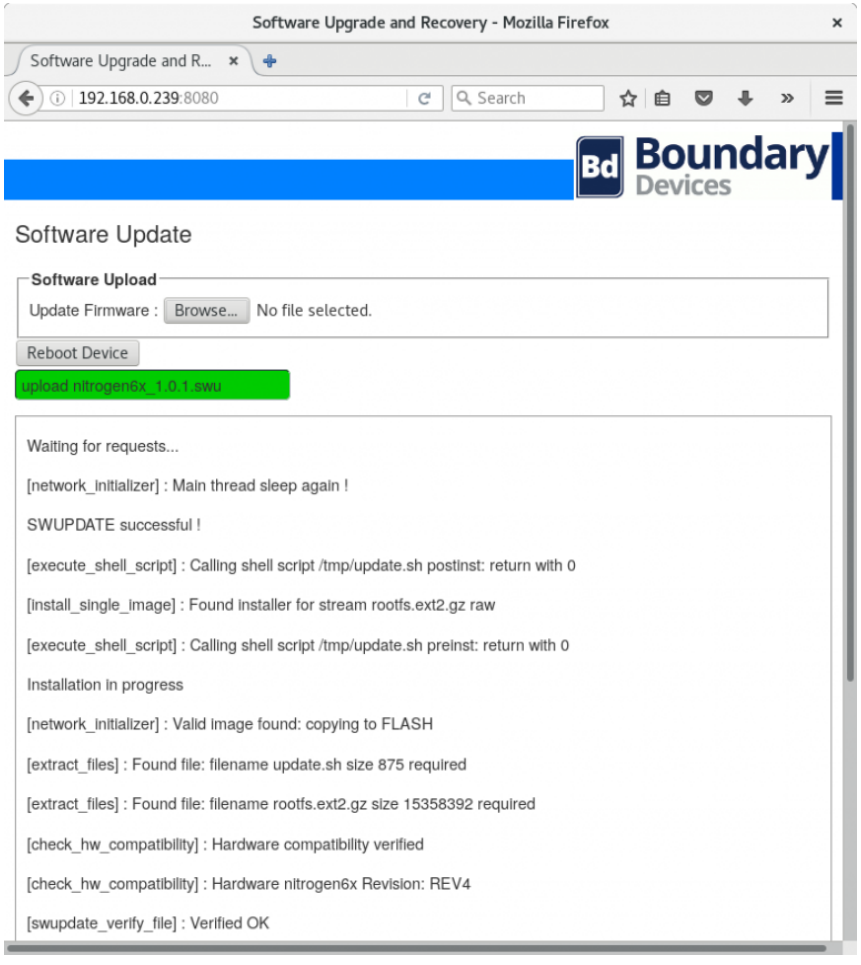
```
swupdate -i <name_of_update>
```

or

```
swupdate -i <name_of_update> -k <pubkey>
```

- In order to automate this procedure, you can create a udev/mdev rule that executes a script every time a USB drive is plugged.
  - mdev automount - tutorial
  - hotplugging with udev - Free Electrons training

OTA UPDATE: MONGOOSE



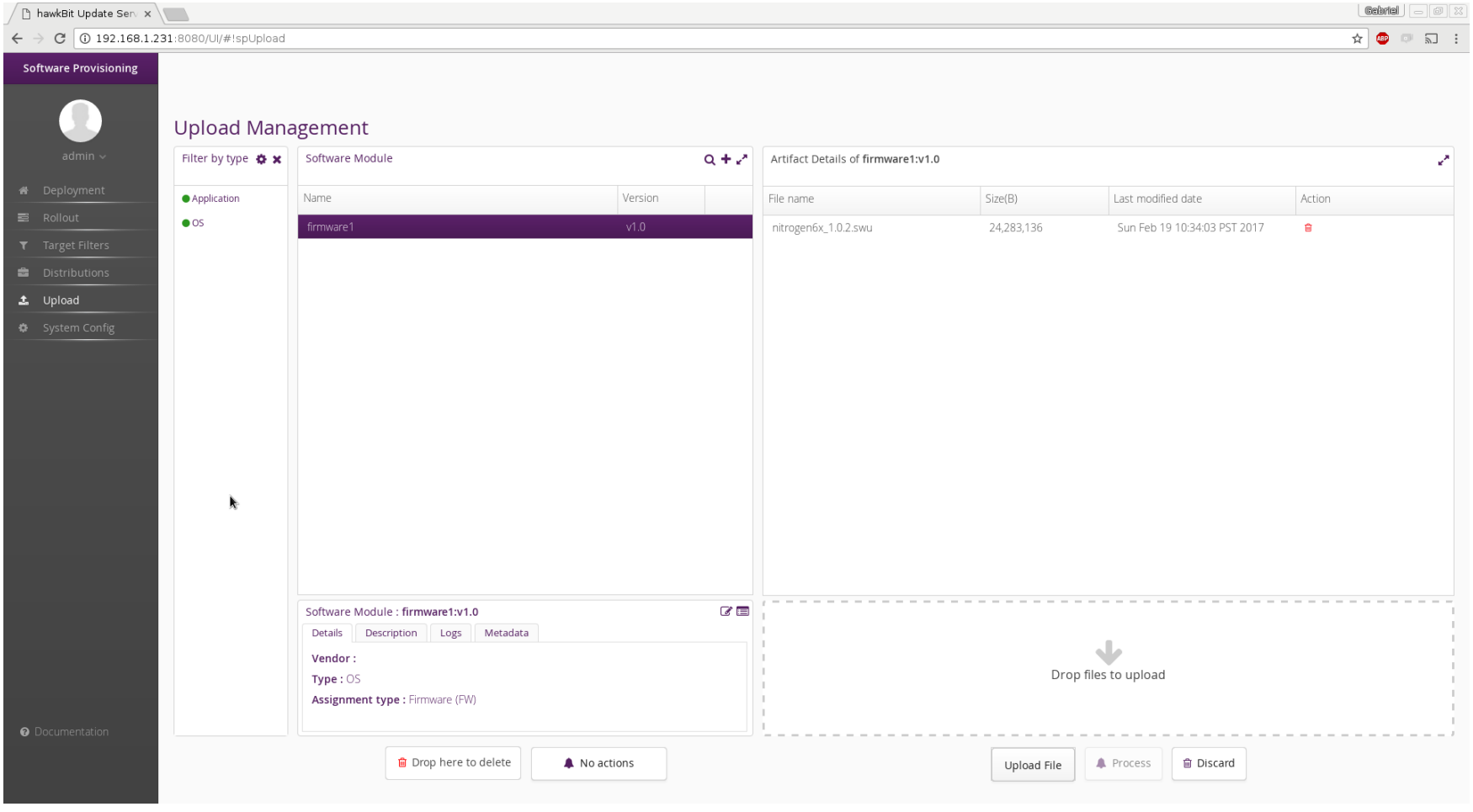

```
swupdate -k <pubkey> -w "-document_root /var/www/swupdate/"
```

OTA UPDATE: DOWNLOAD HTTP

SWUpdate also offers to download the update file from an HTTP server with the -d option:

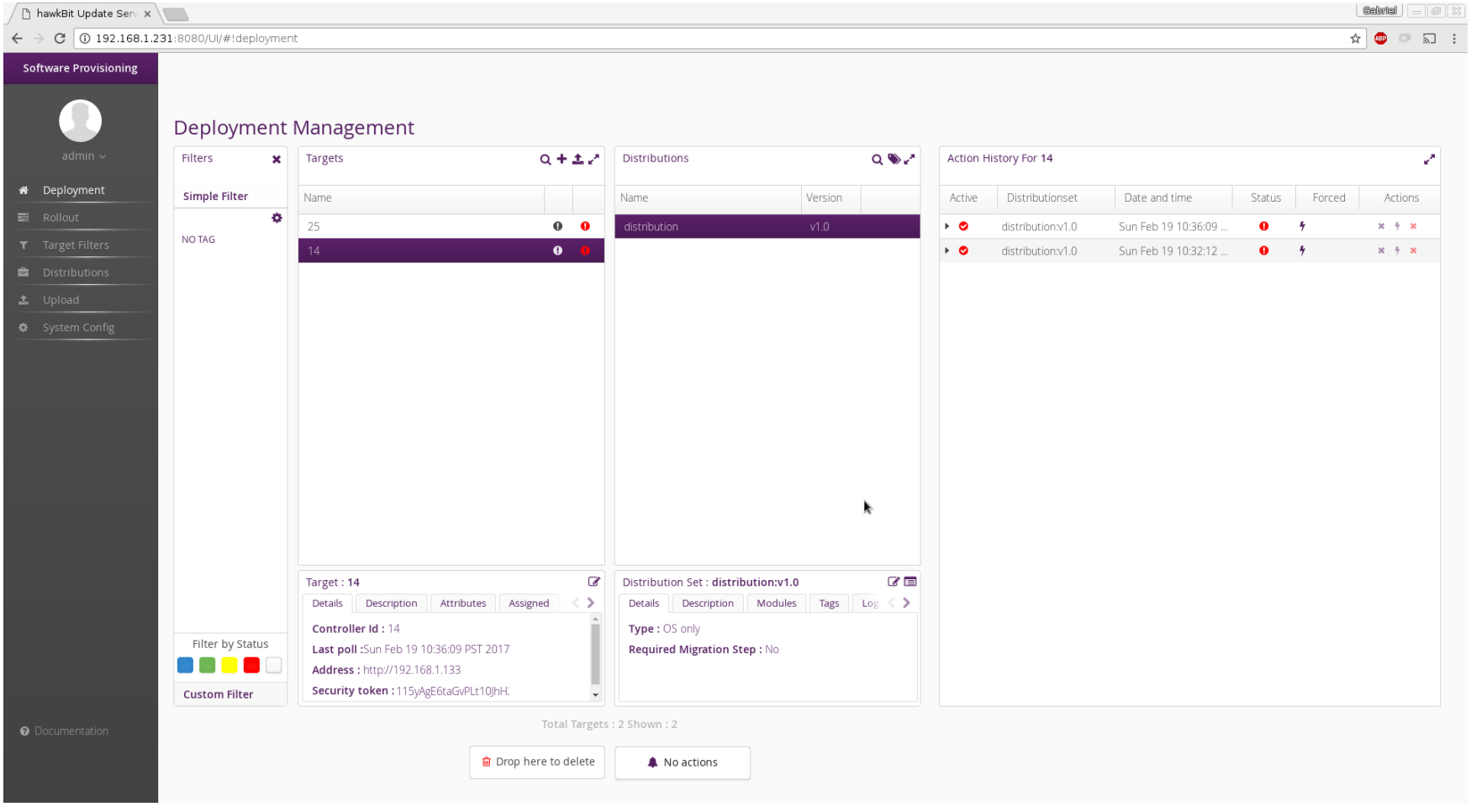
```
swupdate -k <pubkey> -d <url>
```

OTA UPDATE: SURICATTA DAEMON/HAWKBIT




```
swupdate -k <pubkey> -u "<hawkbit options>"
```

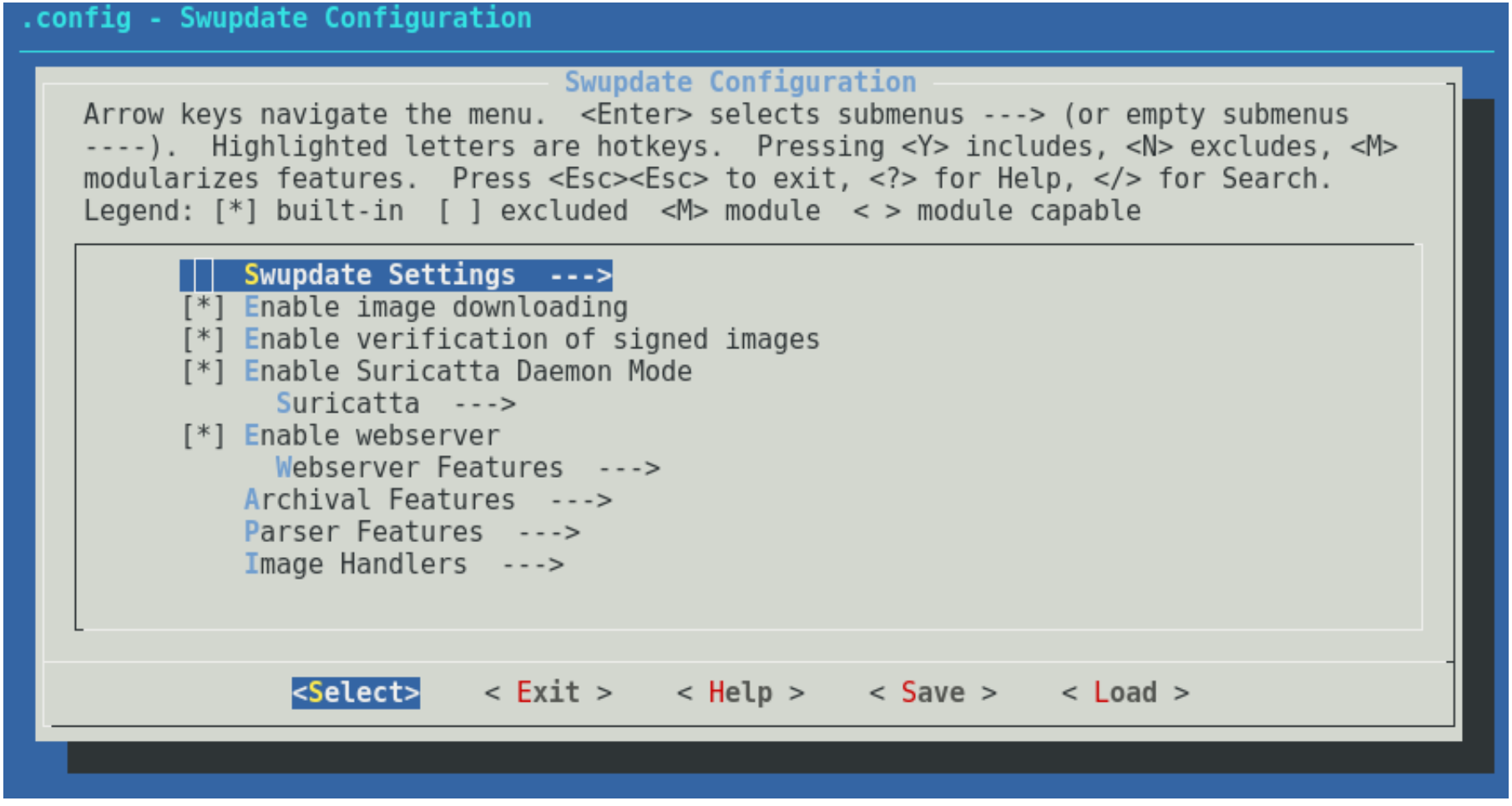
OTA UPDATE: SURICATTA DAEMON/HAWKBIT



Docker is highly advise for tests/demos setup (even production ...)

Customization

MENUCONFIG: SELECT YOUR FEATURES



HANDLERS

- A way to add your own installer
- Don't forget to update handlers/lua/swupdate_handlers.lua ...

```
1  require("swupdate")
2  fpga_handler = function(image)
3        print(" Install  FPGA Software")
4        for k,l in pairs(image) do
5              print("image[" .. tostring(k) .. "] = " .. tostring(l) )
6              swupdate.notify(swupdate.RECOVERY_STATUS.RUN,0,"
       image[" .. tostring(k) .. "] = " .. tostring(l)
7        end
8        return 0
9  end
10 swupdate.register_handler("fpga",fpga_handler)
11
```

HANDLERS

Provided by the framework:

- flash devices in raw mode (both NOR and NAND)
- UBI volumes
- raw devices, such as a SD Card partition
- U-Boot environment
- LUA scripts

But you can also create your own ...

HANDLERS: FLASH DEVICES (NOR, NAND, ...)

```
images:
{
        "version": "2016.01",
        "name": "bootloader",
        "device": "mtd1",
        " install - if - different ": true,
        "type": " flash ",
        "filename": "u-boot.sb"
},

```

HANDLERS: UBI VOLUMES

```
images:
{
        filename = "core-image-full-cmdline.ubifs";
        type = "ubivol";
        volume = "rootfs1"
         installed - directly = true;
}

```

HANDLERS: RAW DEVICES (SD CARD)

```
1 images:
2 {
3       filename = "rootfs.ext2.gz";
4       device = "/dev/mmcblk1p2";
5       compressed = true;
6 }
7
```

HANDLERS: U-BOOT ENVIRONMENT

```
1  images:
2  {
3          filename = "uboot-env";
4          type = "uboot";
5  },
6   ...
7  uboot:
8  {
9          name = "vram";
10         value = "4M";
11 },
12 {
13         name = "addfb";
14         value = "setenv bootargs ${bootargs} omapfb.vram=1:2M,2:2M
           ,3:2M omapdss.def_disp=lcd"
15 }
16
```

HANDLERS: LUA SCRIPTS

```
1  scripts : (
2  {
3          filename = "erase_at_end";
4          type = "lua";
5  },
6  {
7          filename = "display_info";
8          type = "lua";
9  }
10 );
11
```

COLLECTIONS

```
1  software =
2  {
3          ...
4          stable :
5          {
6                  main:
7                  {
8                          images: (
9                          {
10                                 filename = "rootfs.ext3";
11                                 device = "/dev/mmcblk0p2";
12                         }
13                         );
14                 };
15                 alt :
16                 {
17                         images: (
18                         {
19                                 filename = "rootfs.ext3";
20                                 device = "/dev/mmcblk0p1";
21                         }
22                         );
23                 };
24
25         };
26 }
27
```

```
# swupdate -i /mnt/my_update.swu -e stable,alt
```

Integration

YOCTO

- meta-swupdate is provided: https://github.com/sbabic/meta-swupdate
- Only 'single-copy' scheme is generated (rescue image)
- MACHINE=<your machine> bitbake swupdate-image
- Images are generated in tmp/deploy/<your machine>/ (.ext3.gz.u-boot)

YOCTO

- **bitbake bbb-swupate-image**: generate an update (.swu)
- **meta-swupdate/recipes-extended/images/bbb-swu-image.bb**: can be used as an example for your custom 'swupdate images'
- swupdate provides a **class** that can be inherit for your custom build/images

YOCTO

WARNING

Starting the swupdate initrd is platform specific ...

- Load the kernel: load usb 0 0xDEADBEEF zImage
- Load the device tree: load usb 0 0xDEADFEED devicetree.dtb
- Load the swupdate initrd: load usb 0 0xFACEB00C swupdate-image-nitrogen6x.ext3.gz.u-boot
- Start the update: bootz 0xDEADBEEF 0xFACEB00C 0xDEADFEED
- Update in progress ...

BUILDROOT

- package/swupdate is supported in mainline
- BR2_PACKAGE_SWUPDATE has to be enabled
- Default configuration provided in package/swupdate/swupdate.config
- Support of menuconfig through buildroot: make swupdate-menuconfig

BUILDROOT

- From the output/images/ directory, you could run the following script:

```
#!/bin/bash

CONTAINER_VER="1.0.2"
PRODUCT_NAME="sabrelite"
FILES="sw-description rootfs.ext2"

for i in $FILES;do
        echo $i;done | cpio -ov -H crc >  ${PRODUCT_NAME}_${
    CONTAINER_VER}.swu
```

BUILDROOT

```
# mount /dev/sda1 /mnt/
# swupdate -i /mnt/my_update.swu
# reboot
```

TARGETING A SPECIFIC HW/SW VERSION

An update can use /etc/hwrevision and /etc/swversion (CONFIG_HW_COMPATIBILITY)

```
1  software =
2  {
3      version = "1.0.1";
4      target1 = {
5          hardware-compatibility: [ "1.0", "1.2", "1.3" ];
6          ...
7      };
8      target2 = {
9          hardware-compatibility: [ "1.1" ];
10         ...
11     };
12     target3 = {
13         ...
14     };
15 }
16
```

TARGETING A SPECIFIC HW/SW VERSION

Compatible:

```
[NOTIFY] : SWUPDATE running :  [check_hw_compatibility] :
    Hardware nitrogen6x Revision: 1.2
[NOTIFY] : SWUPDATE running :  [check_hw_compatibility] :
    Hardware compatibility verified
[NOTIFY] : SWUPDATE running :  [cpio_scan] : Found file:
```

Not compatible:

```
[NOTIFY] : SWUPDATE running :  [check_hw_compatibility] :
    Hardware nitrogen6x Revision: 1.3
ERROR core/swupdate.c : install_from_file : 317 : SW not
    compatible with hardware
[NOTIFY] : SWUPDATE failed [0] ERROR core/swupdate.c :
    install_from_file : 317 : SW not compatible with hardware
```

SIGNING AN IMAGE

Only the sw-description is signed but all images node must have a hash (sha256 for example)

Example with sha256:

- create the private key

```
openssl genrsa -out swupdate-priv.pem
```

- create the public key

```
openssl rsa -in swupdate-priv.pem -out swupdate-public.pem -
    outform PEM -pubout
```

- sign the image description file

```
openssl dgst -sha256 -sign swupdate-priv.pem sw-description
    > sw-description.sig
```

Once signed, you can ensure that nobody can temper with your update image to include malicious firmware

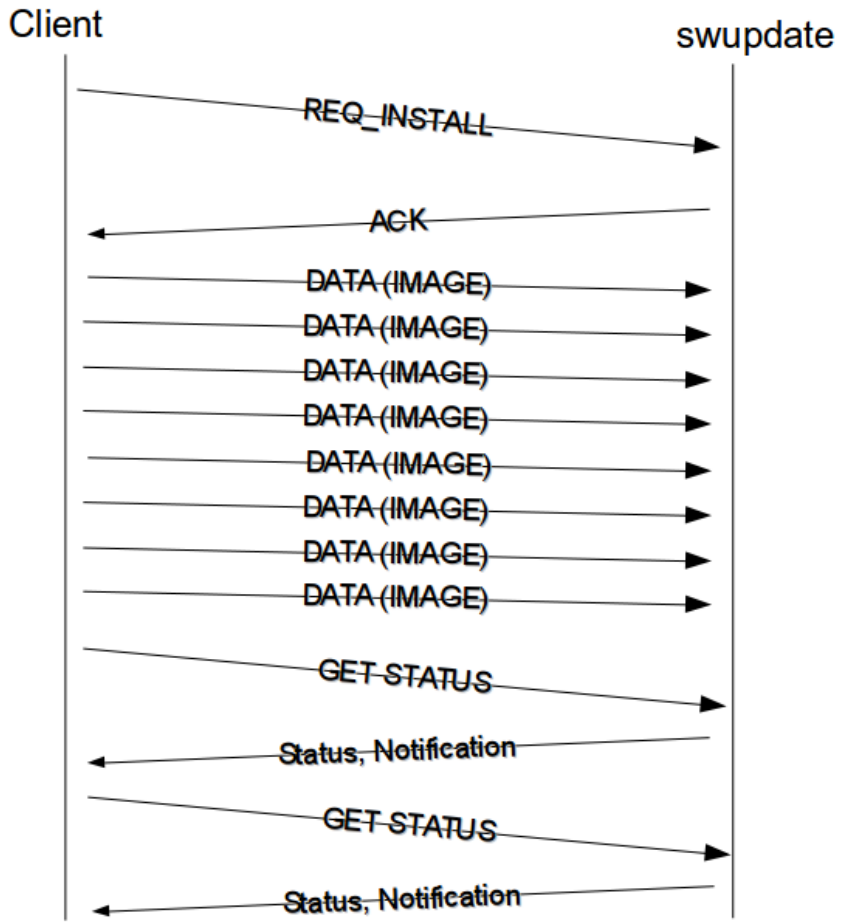
SIGNING AN IMAGE

```
#!/bin/bash

CONTAINER_VER="1.0.1"
PRODUCT_NAME="nitrogen6x"
FILES="sw-description sw-description.sig rootfs.ext2.gz update.sh
    "

openssl dgst -sha256 -sign swupdate-priv.pem sw-description > sw-
    description.sig

for i in $FILES;do
        echo $i;done | cpio -ov -H crc >  ${PRODUCT_NAME}_${
    CONTAINER_VER}.swu
```

API FOR EXTERNAL PROGRAMS

- Communication via UNIX Domain Socket
- Simple interface

```
1 typedef struct {
2         int  magic;
3         int  type;
4         msgdata data;
5 } ipc_message;
6
```



CONCLUSION/DEMOS

Next steps:

- Binary delta updates
- New handlers: FPGA? loading them at runtime?
- More examples and support for evaluation boards!
- More backend like Hawkbit
- Filesystem-based Persistent Update Status Storage
- ...

LINKS

- SWUpdate source code: https://github.com/sbabic/swupdate
- SWUpdate online documentation: https://sbabic.github.io/swupdate
- SWUpdate mailing list: swupdate@googlegroups.com
- Stefano Babic's ELCE presentation: software-update-for-embedded-systems-elce2014
- Boundary Devices blog: **Using SWUpdate** boundarydevices.com/using-swupdate-upgrade-system
- Hawkbit docker: https://github.com/MiloCasagrande/hawkbit-docker.git